International Journal of Academic and Applied Research (IJAAR)
ISSN: 2643-9603
Vol. 7 Issue 6, June - 2023, Pages: 40-48

Teachers Awareness and Practices of Stem as Correlates of Preschool Children's Intellectual Development

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Abstract: *It is important to our society to have schools producing students who are able to move the society forward by contributing positively to the economy through the use of some relevant skills from the field of STEM. Owing to the unprecedented development of technology and therefore of society in recent years, the need for education systems worldwide to modernize the methods and means used is a matter of necessity. Against the traditional, primitive and conventional way of content delivery been used by teachers, the use of pedagogical practices that is more practical oriented and centralize teaching learning activities to children and the one which can help in improving learning ability ultimately for societal development becomes imperative. Hence the study investigated Teachers Awareness and Practices of Stem as Correlates of Preschool Children's Intellectual Development. Three research questions were answered and four hypotheses were tested. The study adopted correlational survey research design. The population of the study comprises all preschool teachers in Oyo Town. Proportionate stratified random sampling was adopted to select 10 schools each from public and private preschools. Simple random sampling technique was adopted to select 100 preschool teachers. Three self-designed instruments were used to elicit responses from the participants. The instruments were validated and tested for reliability. The finding of the study revealed that, preschool teachers are to some extent aware of STEM (WA=) and also the extent to which teachers practice STEM is fair (WA=). It was recommended based on the findings that, there should be proper awareness for preschool teachers on the need to familiarize themselves with STEM which is considered as a global trend. Also, although the level of practice of STEM by teachers is fair, Periodic training and retraining of preschool teachers should be done by the government and private school owners.*

Keywords: Awareness, Practices, Science, Technology, Engineering, Mathematics

Introduction

It is important to our society to have schools producing students who are able to move the society forward by contributing positively to the economy through the use of some relevant skills from the field of STEM. Hence, the use of pedagogical practices to disseminate information and also which can help in improving learning ability ultimately for societal development becomes imperative. For this to happen, there is need for us to introduce the practices to the children since they are in the formative stage. Considering the purpose of pre- primary education in Nigeria, the National Policy on Education (2013), stated that the education for the children of this stage shall be to effect a smooth transition from the to the school; prepare the child for the primary level of education; provide adequate care, supervision and security for the children while their parents are at work; inculcate social, moral norms and values; inculcate in the child the spirit of enquiry and creativity through the exploration of nature, the environment, art music and use and the use of toys; develop a sense of co-operation and team spirit; stimulate in the child good habits, including good health habits; and teach the rudiments of numbers; letters, colours, shapes forms, etc through play. Most of the policy statements dictate that we produced children who have most skills for society development.

The above purpose of pre-primary education can be achieved through the use of play way method and STEM pedagogical approach. This pedagogy allows the children of this level construct their knowledge from exploration made from both in and outside the classroom environment. Florida Department of Education (2022) describes STEM as deliberate integration of Science, Technology, Engineering and Mathematics and their practices to create child- centered learning environment in which child investigate and find solutions to problem. The ability of pre-primary pupils to find solution to a particular problem make them the construct of their knowledge which permit the such learning to be permanent. It is obvious that STEM is the major instrument which society can use to drive development towards herself. Most European countries have realized many benefits from the use of STEM pedagogy in their various schools.

There is connectivity between STEM and the preschoolers because the major work they do here is play. Punjab Colleges (2020) supported this when he says science is a play and natural youthful curiosity that form the basis of this innovative learning - STEM. Play is the work of children, learning is taking place during child's work and knowledge is being constructed. With this pre-primary pupils' work, knowledge developed can be used to solve many problems facing the society. A field of study which has the ability to initiate and make productive use of available resources to solve the needs of society is the demand of all nations. The use of STEM pedagogy for the early years assists them to become innovative thinkers that can move, shake and change the world. As important as this method of learning , one need to examine critically the level at which pre- primary school teachers take cognizance of it and keep the pupils on the lane in order to develop them towards the need of the society.

Early years are curious, they want to know answers to many questions raised and this curiosity serves as the bedrock of STEM, therefore it is important to promote the skill at this stage of life. It has been discovered that during exploration of the environment and toy materials, children try to figure out things to satisfy their curiosity. Free play is important for the exploration therefore teachers should encourage the children to embark on it both in and outside the classroom. The four areas of knowledge that combine to form the acronym of STEM may let some people think that the pedagogy is meant for those who want to go for careers emanated from the field. Knowledge of STEM allows for critical thinking and problem-solving skills. Persistence and coming up with creative solutions are other skills from STEM as described by Engineering for kids (2019). The skills learn from STEM are useful to tackle the challenges of 21st century, such as climate change and unknown problems (Paper pinecone 2020).

Teachers' ability to comprehend and practice the STEM pedagogy will give the children the ability to develop the skills that will make them effective in this 21st century. It is good to use STEM in early childhood class because the brain of the child at this stage is capable to take in new information. Teachers can handle the class by using allowing the pupils to build things of their interest using available materials in the locality, play with water and sand, visit a local science museum, explore the environment, play indoor at STEM learning area (Engineering for Kids 2019).The use of open-ended materials for the pupils to explore and the use of open-ended questions (what and why) encourage the pupils to develop natural curiosity. Teachers in early childhood class need to go for training and retraining of STEM education so as to equip them for effective use of the method.

Going through the goals of Basic Education in the National Policy on Education (2013), it was stated that Government would like to: provide the child with diverse basic knowledge and skills; develop patriotic young people equipped to contribute to social development and in the performance of their civic responsibilities; inculcate values and raise morally upright individuals capable of independent thinking, and who appreciate the dignity of labour; inspire national consciousness and harmonious co-existence irrespective of differences in endowment, religion, ethnic and socioeconomic background; and provide opportunities for the child to develop manipulative skills that will enable the child function effectively in the society within the limits of the child's capacity. The only way to achieve these goals is to create an avenue for training and retraining of the basic education teachers and this will give them the competency of using STEM in early childhood class. Teachers should create a smooth relationship with the parents so that the knowledge of STEM gained by the pupils in the school will continue at home.

STEM skills to be developed in early years according to Center for Energy Workforce Development (2021) stated as:

1. Problem Solving: This skill gives the ability to proffer appropriate solution to a given problem as quickly as possible.
2. Creativity: This is looking at a problem through many approaches to arrive at solutions, it involves the ability of being highly creative or "out-of-the-box" STEM accommodates mistakes and failed attempt because it is the belief that it give chances for deeper learning.
3. Inquiry Skills: In solving problem in STEM, the use of hands-on and active participation is needed. Pupils should be given the chances of looking for solution to problems so as to equip them on how to make decisions based on available fact in future.
4. Math and Science Skills: These are the bedrock of STEM which must be used in the pursuit of solutions. There are so many useful skills we can learn from these two areas of knowledge. The skills of measurement, spatial sense, number sense, patterns formation, guessing, objectivity, curiosity and others are the skills pupils are exposed to.
5. Engineering Design Thinking: This skill can only be achieved if enough play materials are provided for pupils in preschool classes, the pupils can build things of their choices.
6. Critical Thinking: To become an independent thinker, ability to analyze information, evaluate designs, reflection on your thinking, synthesizing new ideas and proposing creative solution are the skills are necessary.
7. Collaboration: Team work usually solve big challenges, so it is of high important to develop this in children and let them know that many time big challenges may be solve by an individual. It teaches perseverance, tolerance and respect for other people's opinion.

Children holistic development is necessary to make them live successful and contribute happily to the society, this development includes intellectual or cognitive, physical, social and emotional. Intellectual development is refers to the way a child think, explore, and figure things out. It is the development of knowledge, skills, problem- solving and dispositions which assist a child to think about and understand the world around him. Qamar (2022) states that intellectual development is the ability to think and process things reasonably. Children are in their formative years, then the parents and teachers need to be warm, caring and responsive to allow for proper intellectual development. Absence of strong affectionate and caring relationship may slow children's curiosity and lead to poor holistic development (Omotuyole &Ige 2016). Parents and teachers need to work on intellectual development of children at this early years because it is gives solid foundation for their future success and life long learning.

There are many works from scholars on STEM and its benefits to the populace, so also much have been done on child development but much have not been done on the use of STEM for the intellectual development of children in early years. This paper therefore, investigates teacher's awareness and practices of STEM toward intellectual development of children in early years. The study will assists the educational stakeholders to make provision of materials needed for early years so as to develop STEM skills necessary for successful living in 21st century.

Research Questions

Research Question One: What is the level of teachers awareness of STEM?

Research Question Two: What is the level of utilization of teachers as regards STEM?

Research Question Three: What is the level of intellectual development of the preschool children on content related to STEM?

Hypotheses

$H_{O1:}$ There is no significant relationship between teachers' awareness of STEM and the intellectual development of preschool children

$H_{O2:}$ There is no significant relationship between teachers' practice of STEM and the intellectual development of preschool children

$H_{O3:}$ There is no significant relationship among various levels of teaching qualification and

(a). teachers awareness of STEM

(b). Teachers practices of STEM

METHODOLOGY

The study adopted correlational survey research design. The population for the study comprises all preschool teachers in Ijebu Ode Local Government. Multistage random sampling was adopted for the study. Proportionate stratified random sampling was to select 10 public and 10 private schools. Simple random sampling was adopted to select 100 preschool teachers selected from 20 (10 public and 10 private) schools (i.e. 5 preschool teachers in each selected school). Hence, a total of 100 respondents participated in the study. Three self-designed instruments were used to elicit responses from the participants. The first instrument titled 'questionnaire on the awareness level of preschool children on STEM (QALPCS)' comprises 2 sections. Section A enlists the demographic information of respondents (Locale and gender) while section B contains 10 statements that seek respondent's views on the subject matter. The second instrument titled 'teachers class observation schedule on the practice of STEM (TCOSPS)' comprises 2 sections, Section A reveals the demographic information of respondents (Qualification and School type) while section B contains 10 statements that seeks respondent's views on the subject matter. The third instrument is children's classroom intellectual development assessment scale (CCIdAS). The two instruments were subjected to validity by giving copies out to some experts in the department of early childhood education, language experts and experts in test and measurement. Highlighted corrections were made and the instruments were adjudged valid. The reliability of the instruments was ascertained using cronbach alpha reliability technique. The reliability index of (α=0.83) and (α=0.81) were calculated for (QALPCS) and (TCOSPS) respectively. The method of data analysis adopted for the study was descriptive statistics (frequency count, simple percentage, mean and standard deviation) and inferential statistics (ANOVA and PPMC).

RESULTS

ANSWERING RESEARCH QUESTIONS

Research Question One: What is the level of teachers' awareness of STEM?

Table 4.1 Descriptive Table Showing the level of teachers' Awareness on STEM

S/N	Items	Fully Aware	Aware	Fairly Aware	Not Aware	Mean	SD
1	STEM is a multi-discipline approach to teaching even at the early years education program	30 (30)	66 (66)	4 (4)	_	3.60	0.56
2	STEM education is a teaching approach that combines science, technology, engineering and math	45 (45)	42 (42)	12 (12)	1	3.28	0.71
3	STEM is designed to encourage discussions and problem-solving and practical skills for through collaborations	35 (35)	63 (63)	2 (2)	_	3.61	0.53
4	STEM education integrates concepts that are usually taught as separate subjects in different classes and emphasizes the application of knowledge to real-life situations	44 (44)	38 (38)	16 (16)	2 (2)	3.22	0.59
5	A lesson or unit in a STEM class is typically based around finding a solution to a real-world problem and tends to emphasize project-based learning.	24 (24)	76 (76)	_	_	3.70	0.44
6	It motivates and inspires young people to generate new technologies and ideas. With a focus on practice and innovation, students get to learn from inquiry-based assignments	39 (39)	50 (500	8 (8)	3 (3)	3.41	0.74
7	STEM education gives an understanding of concepts and encourages knowledge application. To keep it short, its aim can be formulated in two simple actions: explore and experience	37 (37)	47 (47)	12 (12)	4 (4)	3.30	0.81
8	Technology prepares young people to work in an environment full of high-tech innovations	46 (46)	27 (27)	21 (21)	6 (6)	2.00	0.81
9	Mathematics in STEM enables people to analyze information, eliminate errors, and make conscious decisions when designing solutions	41 (41)	46 (46)	11 (11)	2 (2)	3.35	0.73
10	The STEM approach to education fosters creativity and divergent thinking alongside fundamental disciplines	39 (39)	32 (32)	21 (21)	8 (8)	3.00	0.95
Weighted Average Mean= 3.2 (80%) Aware							

The table above revealed that teachers are aware of STEM education and the level of teachers awareness of STEM is fair (WA=3.2). The detailed explanation is as follows; teachers are aware that; A lesson or unit in a STEM class is typically based around finding a solution to a real-world problem and tends to emphasize project-based learning (π=3.70), STEM is designed to encourage discussions and problem-solving and practical skills for through collaborations (π=3.61), STEM is a multi-discipline approach to teaching even at the early years education program (π=3.6), STEM motivates and inspires young people to generate new technologies and ideas, with a focus on practice and innovation, students get to learn from inquiry-based assignments (3 π=.4), Mathematics in STEM enables people to analyze information, eliminate errors, and make conscious decisions when designing solutions (π=3.35), STEM education gives an understanding of concepts and encourages knowledge application. To keep it short, its aim can be formulated in two simple actions: explore and experience (π=3.30), STEM education is a teaching approach that combines science, technology, engineering and math (π=3.28), STEM education integrates concepts that are usually taught as separate subjects in different classes and emphasizes the application of knowledge to real-life situations (π=3.22), The STEM approach to education fosters creativity and divergent thinking alongside fundamental disciplines (π=3.00), Technology prepares young people to work in an environment full of high-tech innovations (π=2.00)

Research Question Two: What is the level of utilization of teachers as regards STEM?

Table 4.2 Descriptive Table Showing the level of teachers' Utilization of STEM

S/N	Items	Excellent	Good	Fair	Poor	Mean	SD
1	Teachers ability to guide and provide limited information and corrections when learners make mistakes	30 (30)	66 (66)	4 (4)	_	3.2	0.56
2	Teachers ability to ask questions and encourage independent thinking	45 (45)	42 (42)	12 (12)	1	3.02	0.71
3	Teachers ability to encourages learners to learn skills and apply their knowledge by taking part in a project	35 (35)	63 (63)	2 (2)	_	3.1	0.53
4	Teacher ability to facilitate and encourage learners to take full control of their projects from start to finish	44 (44)	38 (38)	16 (16)	2 (2)	3.02	0.59
5	Teachers ability to give opportunity to learners to analyse and evaluate a problem that is posed to them.	24 (24)	76 (76)	_	_	3.07	0.44
6	Teachers ability to give tasks that spark curiosity and prompt reflection to children	39 (39)	50 (500	8 (8)	3 (3)	3.04	0.74
7	Teachers ability to provide for opportunities for practical activities where learners can use their hands e.g. designing a concept or creating and building something themselves	37 (37)	47 (47)	12 (12)	4 (4)	3.1	0.81
8	Teachers ability to present maths and science activities which should be relevant to their current project, relate to real-world scenarios and ultimately serve a purpose	46 (46)	27 (27)	21 (21)	6 (6)	2.7	0.81
9	Teachers ability to present STEM activities taking cognizance of different age ranges, abilities, group sizes and interests	41 (41)	46 (46)	11 (11)	2 (2)	3.20	0.73
10	Teachers ability to incorporate Digital literacy in STEM class	39 (39)	32 (32)	21 (21)	8 (8)	2.70	0.95
Weighted Average Mean= 3.0 (75%)							

The table above revealed that teachers to some extent practice STEM Education in the class (WA=3.0). The detailed explanation is as follows; teachers to some extent guide and provide limited information and corrections when learners make mistakes (π=3.2), Teachers are able to encourage learners to learn skills and apply their knowledge by taking part in a project (π=3.1), Teachers ability to provide for opportunities for practical activities where learners can use their hands e.g. designing a concept or creating and building something themselves (π=3.1), Teachers ability to present STEM activities taking cognizance of different age ranges, abilities, group sizes and interests (π=3.2). However, teachers did not perform well in the following aspects asking questions and encourage independent thinking, encouraging learners to take full control of their projects from start to finish, facilitating and encouraging learners to take full control of their projects from start to finish, presenting maths and science activities which should be relevant to their current project, relate to real-world scenarios and ultimately serve a purpose, and lastly, incorporating Digital literacy in STEM class

Research Question Three: What is the level of intellectual development of the preschool children on content related to STEM?

Table 4.3 Showing the level of Intellectual development of the Preschool Children

Actual Score	Aggregate	Frequency	%	Mean Score	SD	Remark
0-12.5	0-49%	10	10	21.9	3.469	Poor
12.6-13.75	50-55%	24	24			Fair
13.8-17	66-69%	30	30			Good
17.5-25	70% and above	36	36			Excellent
Total	**100**	**100**				

Table 4.5 shows that the intellectual development of preschool children in relation to STEM content is adequate (mean = 21.9). The detailed analysis is as follows: learners who scores are between 0-12.5 were rated poor with a frequency of 10 which accounted for 10% of the sampled population, learners with scores ranging from 12.6-13.75 were rated fair with a frequency of 24 which accounted for 24% of the sampled population, learners with scores ranging from 13.76-17 were rated good with a frequency of 30 which accounted for 30% of the sampled population, and learners with scores ranging from 17.5-25 were rated excellent with a frequency of 36 which accounted for 36% of the sampled population.

HYPOTHESES TESTING

$H_{O1:}$ There is no significant relationship between teachers' awareness of STEM and the intellectual development of preschool children

Table 4.4: Summary of PPMC Showing the Relationship between Teachers' Awareness of STEM and Intellectual Development of Pre-school Children

Variable	N	Mean	Std.d	r	Sig.	Remark
Awareness of STEM	100	15.617	3.622	0.031	0.833	Not Significant
Intellectual Development	100	12.400	4.549			

Table 4.3 shows that there is no significant relationship between teachers' awareness of STEM and the intellectual development of preschool children ($r = 0.03$; $p>0.05$). Therefore hypothesis one is not rejected. This implies that the level of awareness of STEM does not influence the intellectual development of learners on STEM content knowledge. This finding is supported by the finding on the descriptive table on teachers awareness. Which reveal that teachers to some extent are aware of STEM.

$H_{O2:}$ There is no significant relationship between teachers' practice of STEM and the intellectual development of preschool children

Table 4.5 Summary of PPMC Showing the relationship between teachers' practice of STEM and the intellectual development of preschool children

Variable	N	Mean	SD	R	Sig	Remark
Practice of STEM	100	37.16	10.38	0.34**	0.00	Significant
Intellectual development	100	43.25	16.51			

The table above revealed that there is significant positive relationship between teachers' practice of STEM and the intellectual development of preschool children ($r=0.34^{**}$;$P<0.05$). Hence, hypothesis 1 is rejected. The implication of the finding is that although

teachers to some extent practice STEM while teaching, and the little practice teachers engage in with the children have positive influence on the learners.

$H_{O3:}$ There is no significant relationship among various levels of teaching qualification and

(a). teachers awareness of STEM

Table 4.6: Summary of ANOVA showing the Relationship among various levels of teaching qualification and teachers awareness of STEM

Variables	N	Mean	Standard Deviation	Df	F	Sig.	Remark
O'level	7	28.3	3.51	3,66	0.447	0.720	Not significant
N.C.E	59	22.10	3.90				
B.Ed/B.A/Bsc/Equivalent	24	21.07	2.30				
No indication	10	23.00	2.08				
Total	**100**	**21.93**	**3.47**				

Table 4.7 shows that there is no significant relationship among various levels of teaching qualification and teachers awareness of STEM ($F_{(3, 66)} = 0.45$; $P > 0.05$). Therefore, hypothesis 3a will not be rejected. This implies that, teachers fair level of awareness of teachers on STEM is not attributed to their qualification.

$H_{O3:}$ There is no significant relationship among various levels of teaching qualification and

(b). teachers Practice of STEM

Table 4.7: Summary of ANOVA showing the Relationship among various levels of teaching qualification and teachers Practice of STEM

Variables	N	Mean	Standard Deviation	Df	F	Sig.	Remark
O'level	7	28.3	3.51	3,66	0.447	0.720	Not significant
N.C.E	59	22.10	3.90				
B.Ed/B.A/Bsc/Equivalent	24	21.07	2.30				
No indication	10	23.00	2.08				
Total	**100**	**21.93**	**3.47**				

Table 4.7 shows that there is no significant relationship among various levels of teaching qualification and teachers Practice of STEM ($F_{(3, 66)} = 0.45$; $P > 0.05$). Therefore, hypothesis 3b will not be rejected. This implies that, teachers fair level of practice STEM is not attributed to their qualification.

Summary of Findings

- Teachers are aware of STEM education and the level of teachers awareness of STEM is high
- There is significant positive relationship between teachers' practice of STEM and the intellectual development of preschool children
- The intellectual development of preschool children in relation to STEM content is adequate
- There is no significant relationship between teachers' awareness of STEM and the intellectual development of preschool children
- There is significant positive relationship between teachers' practice of STEM and the intellectual development of preschool children
- There is no significant relationship among various levels of teaching qualification and teachers awareness of STEM
- There is no significant relationship among various levels of teaching qualification and teachers Practice of STEM

Discussion of Findings

Measuring the impact of a STEM curriculum on early development is difficult, but STEM education has been shown to be a predictor of future academic achievement. For example, a study by researchers at the University of California Irvine found that early math skills were the most consistently predictive measure of future academic success among kindergarten to fifth grade students.

The benefits of STEM education are not limited to a student's academic career, however. Efforts in the US to improve STEM education have largely been driven by demand from the private sector, where employers have complained about a lack of qualified candidates for technology-focused jobs. The US Bureau of Labor Statistics (BLS) projects 5 percent growth in non-STEM occupations between 2018 and 2028, while the number of STEM-related jobs will grow almost 9 percent, expanding by 10.6 million positions.

The findings on the Mathematics section hint that teachers integrate this STEM field in their classroom on a satisfactory level. The instruction of mathematics is indeed extremely significant for preschoolers, as it provides valuable knowledge and skills for their future life, such as computational skills. Despite of the teachers' positive view on pre-school mathematics, it is broadly admitted that teachers misunderstand the process of teaching math.
According to Katsikas, & Gritzalis (2017), teachers often link mathematics education with keeping students occupied with math activities and simply using the names of mathematical concepts in their verbal interactions. Although, this type of math education is inadequate, since it does not help children develop mathematical thinking. The letter "M" in STEM is mostly used to define the instruction of mathematical units, as found in the preschool curriculum of Cyprus. Amongst those units, teachers highlight the usefulness of geometry and numeracy and operations.

Undoubtedly, the "meaning of the number" (Alexandros & Argyris, 2007) is concretely important for children, as it is the foundation for mathematical reasoning and comprehending complex numerical models (Verschaffel, Greer, Torbeyens, 2006). Additionally, the instruction of geometry in early years is considered necessary for the development of useful skills such as spatial reasoning (Papic, & Mulligan, 2007) and "visualization" (Bishop, 2006), which is linked to STEM education through the field of Technology. Teachers believe that units of measurement and algebra are less useful for children this age. However, according to Rogers (2012), there should be included measurement activities in pre-school mathematics, since they provide children the ability to compare objects and understand the use of metric systems. Regarding the instruction of algebra teachers consider that it is less useful, although it is necessary for the children to get acquainted with repeating patterns given that they are capable of developing complex patterning concepts and this expands their cognitive skills (Papic & Mulligan, 2007).

Recommendations

- There should be proper awareness for preschool teachers on the need to familiarize themselves with STEM which is considered as a global trend
- Although the level of practice of STEM by teachers is fair, Periodic training and retraining of preschool teachers should be done by the government and private school owners
- Qualifies, experienced and professional preschool teachers, who understands the dynamic nature of children and who is ready to adjust to global trends as regards child learning and development should be employed to

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Others
assume that STEM is a teaching method or an activity for developing the different skills necessary to solve real-life problems. The STEM education, as stated by the pre-servic